INSTRUCTION MANUAL

FL-110

YAESU MUSEN CO., LTD.
TOKYO, JAPAN

FL-110 LINEAR AMPLIFIER



GENERAL

The FL-110 is an all solid state linear amplifier designed to match the FT-301S and FT-7 transceivers covering ham bands 160 through 10 meters.

The FL-110 uses a pair of SRF-1427 transistors in a push-pull, broad-band linear amplifier circuit configuration with negative feedback reducing the distortion and spurious radiation.

The Automatic Level Control Circuit controls the exciter gain to allow the highest average power without distortion caused by peak clipping, and, protects the PA transistor from destruction due to overdrive.

An internal change-over relay is operated automatically by either a transmitted signal or PTT switch in the exciter.

CAUTION

DO NOT EXCEED RATED DRIVE
POWER OR DESTRUCTION OF
THE PA TRANSISTOR MAY RESULT.

SPECIFICATIONS

Circuit	-	Transistorized push-pull, wide-band linear amplifier.
Frequency Coverage	-	Ham bands 160 through 10 meters.
Wave Form	-	SSB, AM, CW and FSK
Max. Drive Power	-	15 watts CW, SSB 4 watts AM, FSK
Input Impedance	-	50 ohms unbalanced
Output Impedance	-	50 ohms unbalanced
Max. Input Power	-	200 watts DC SSB, CW 75 watts DC FSK 50 watts DC AM
Distortion	-	Better than 31 db
Spurious Radiation	-	Less than -40 db
Power Requirement	-	13.5V DC ±10% negative ground Receive 0.05 amps Transmit 17 amps at 100 watts Output 14 MHz
Size	-	120(W) x 100(H) x 200(D) m/m
Weight	-	2.5 kg

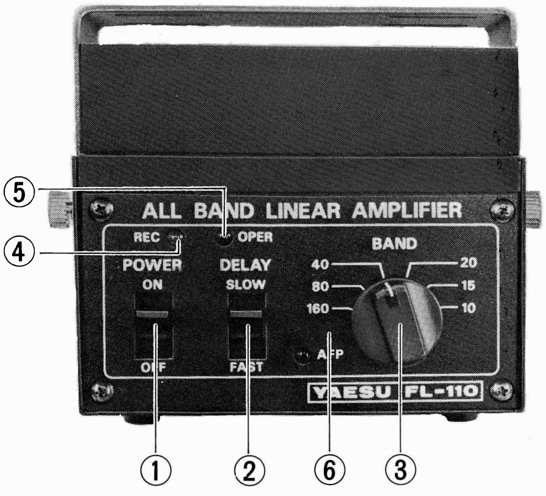
SEMICONDUCTOR COMPLEMENT

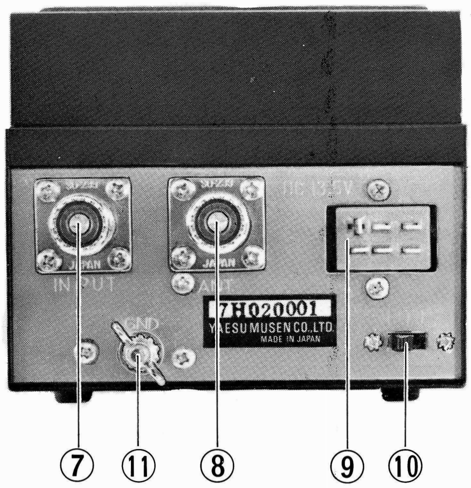
IC	μPC271C	(1)	DIODE	1S-1007	(12)
TR	2SC372Y	(1)		10D1	(3)
	2SC735Y	(1)		10D10	(2)
	2SD235	(1)		SG103D	(1)
	SRF1427	(2)		SR103D	(2)
				CW01B	(1)

"CAUTION"

EXCEEDING CURRENT LEVEL AS LISTED IN OPERATING MANUAL MAY CAUSE SPURIOUS IN VIOLATION OF FCC RULE 97.73.

CONTROLS, INDICATORS & CONNECTORS





Front Panel

(1)	POWER	-	Switch to turn power "ON".
(2)	DELAY	-	Switch selects relay hold time for carrier operated change-over. Relay time is 0.1 - 0.2 seconds for FAST and 0.3 - 1.0 seconds for SLOW positions.
(3)	BAND	-	Switch selects the Amateur band between 160 and 10 meters.
	INDICATORS		
(4)	REC:	-	Green lamp indicates receive mode.
(5)	OPER:	-	Red lamp indicates transmit mode.
(6)	AFP:	-	Red lamp indicates that the AFP circuit is in operation and that the linear amp is shut down.

Rear Panel

(7)	INPUT	-	Input connector for the drive from exciter.
(8)	ANT	-	Antenna connector.
(9)	POWER	-	DC-13.5V, 20A power input. External PTT control terminal is included.
(10)	PTT	-	Switch to select relay polarity.
(11)	GND	-	Ground connection.

INSTALLATION AND OPERATION

The FL-110 Linear Amplifier is installed and operated very simply. It requires only a 13.5 volts DC power source and an antenna. However, the following points are very important, therefore, please read them carefully before installing and operating the FL-110.

CAUTION

PERMANENT DAMAGE WILL RESULT IF THE WRONG POLARITY OF DC POWER VOLTAGE IS APPLIED TO THE FL-110. OUR WARRANTY DOES NOT COVER THE DAMAGE WHICH WOULD RESULT TO THE AMPLIFIER IF THE INCORRECT POLARITY WAS APPLIED.

The FL-110 will operate satisfactorily from any 12 - 14 volts DC power source having a 20A current capacity. When making connections to the power source, be certain the the ORANGE lead is connected to the positive (+) and the BLACK lead to the negative (-).

The power cable should be as short as possible to minimize voltage drop and to provide a low impedance path from the FL-110 to the power supply.

Prior to operating the FL-110 in a mobile installation, the automobile's voltage regulator setting should be checked. In many vehicles, the voltage regulator is very poor and, in some cases, the regulator may be adjusted for an excessively high charging voltage. It is necessary to carefully set the regulator so that the highest charging voltage does not exceed 14 volts.

No special installing precautions need be observed if adequate ventilation space is available. However, it is recommended that excessively warm locations, such as car heater ducts, should be avoided. The FL-110 should be installed in such a way so that the heat sink is on top.

It is also very important that the antenna used with the FL-110 presents a fairly close 50 ohms non-reactive load. If the SWR is as high as 2:1, the output power decreases and the AFP circuit will work with SWR 3:1 to protect the power transistor.

The FL-110 can be keyed either manually or automatically.

For manual operation, use the accessory relay output of the transceiver in use as illustrated in Fig. 1. With this interconnection, the FL-110 is keyed by push-to-talk operation of the transceiver.

Carefully examine the relay function of the transceiver.

The switch marked PTT on the rear panel should be set to (-) for the transceiver which has the accessory relay contact close to ground in transmit (FT-101 series). It should be set to (+) position for the transceiver which has the relay contact close to a positive voltage in transmit (FT-301 series).

Use a coax cable for the connection between the transceiver and the FL-110 linear amplifier.

CAUTION

THE DRIVING POWER SHOULD NOT EXCEED 15 WATTS UNDER ANY CIRCUMSTANCES.

DO NOT KEY THE FL-110 WITHOUT THE PROPER ANTENNA BEING CONNECTED.

THE COLLECTOR OF THE PA TRANSISTOR IS CONNECTED TO THE POWER SOURCE AND DRAWS 5 MILLIAMPS WHEN THE POWER SWITCH IS AT "OFF" POSITION. THEREFORE, IT IS RECOMMENDED TO DISCONNECT POWER CABLE FROM THE BATTERY WHEN THE FL-110 IS NOT BEING USED FOR SEVERAL MONTHS.

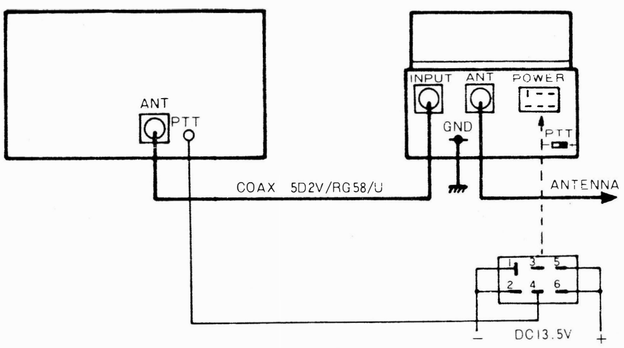


Figure 1

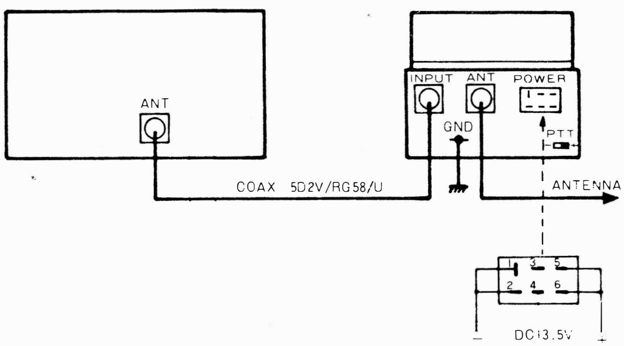


Figure 2

When the power switch is set to "OFF" position, the FL-110 does not operate and the antenna is directly connected to the transceiver. When the power switch is "ON", a green lamp lights up and the FL-110 is keyed together with the transceiver. On transmit, a red lamp lights up.

The FL-110 can operate automatically when the transceiver is operated by VOX (voice controlled) mode. The transmitter carrier from the transceiver controls the change-over relay in the FL-110. The relay hold time is set to either FAST or SLOW to select delay time of the change-over relay. When the FL-110 is operated with the lower driving power of less than 1 watt, the carrier operated change-over circuit does not function.

CAUTION

IF THE AFP (AUTOMATIC FINAL PROTECTION) CIRCUIT STARTS TO WORK, A RED WARNING LAMP LIGHTS UP SHOWING THAT THE LINEAR AMPLIFIER IS NOT FUNCTIONING.

IF THIS HAPPENS, TURN THE POWER SWITCH "OFF" AND CHECK FOR THE CAUSE OF TROUBLE WHICH WILL BE EITHER A DEFECTIVE ANTENNA SYSTEM OR OVERDRIVE FROM THE EXCITER.

AFTER ELIMINATING THE PROBLEM, THE AFP CIRCUIT CAN BE RESET BY TURNING THE POWER SWITCH "ON".

CIRCUIT DESCRIPTION

The FL-110 consists of four major parts -- COUPLING UNIT, CONTROL UNIT, BOOSTER UNIT and LPF unit. On receive mode, a received signal is fed through J1, RL1 and J2 to the transceiver antenna terminal.

On transmit, the output signal from the transceiver antenna passes through the CM coupler T101 in the coupler unit PB-1680 where the RF voltage is detected and applied to the control unit PB-1681 in order to activate the relay RL1.

A forwarding wave is detected by the voltage doubler rectifier D101 and D103, 1S-1007 and a reflected wave is detected by D102 and D104, 1S-1007. The rectified DC voltages are applied to a comparator Q204, μPC-271C which controls relay driver, Q201, 2SC372Y and Q202, 2SC735Y. With high reflected wave, such as VSWR 1:3, the output of Q204 is low and the relay driver circuit does not function.

A part of the DC voltage obtained from the forwarding wave is applied to the AFP circuit in order to operate RL201 to disconnect the activating voltage for RL1 thus protecting the PA transistors from damage due to overdrive. The relay hold time is set to either FAST or SLOW by adding C201 for a longer discharge time.

When RL1 is activated, the bias voltage is applied to the PA transistors and the amplifier starts to operate.

The driving power is fed through the equalizer circuit consisting of R1210, R1211, C1201, C1202, R1201, R1202 and L1201 to the input transformer T1201 to be amplified by Q1201 and Q1202, SRF-1427 which works as a wide-band linear amplifier in a push-pull configuration.

The Negative Feedback circuit consisting of R1206, L1204, R1204 and L1203 improves the stability and the linearity of the PA stage.

The 13.5 Volt DC voltage is regulated to 0.65 volts by a regulator Q1203, 2SD235 to be used as bias for Q1201 and Q1202. Q1203 is controlled by the voltage generated by D1201 and D1202, 10D10 which varies in accordance with the temperature of the final transistor in order to protect the final transistor.

The amplified output is fed through the Low-Pass Filter Unit, PB-1577 which reduces the harmonic radiation, and then passes through relay RL1 to the antenna.

A portion of the output power is coupled through T301 to the AFP circuit.

The DC voltage obtained by rectifying the forwarding power with D302 and D304, 1S-1007 is fed to Q203, CW01B which controls RL201 to open RL1 when the output power exceeds preset value set by VR301.

The DC voltage obtained by a reflected power caused by high VSWR (more than 1:3) also controls Q203 to open RL1.

MAINTENANCE AND ALIGNMENT

Your FL-110 Linear Amplifier has been carefully aligned and tested at our factory prior to shipment. The reliability of the solid state devices used in the FL-110 should provide years of trouble-free service if the amplifier is not abused, and, normal routine maintenance is carried out.

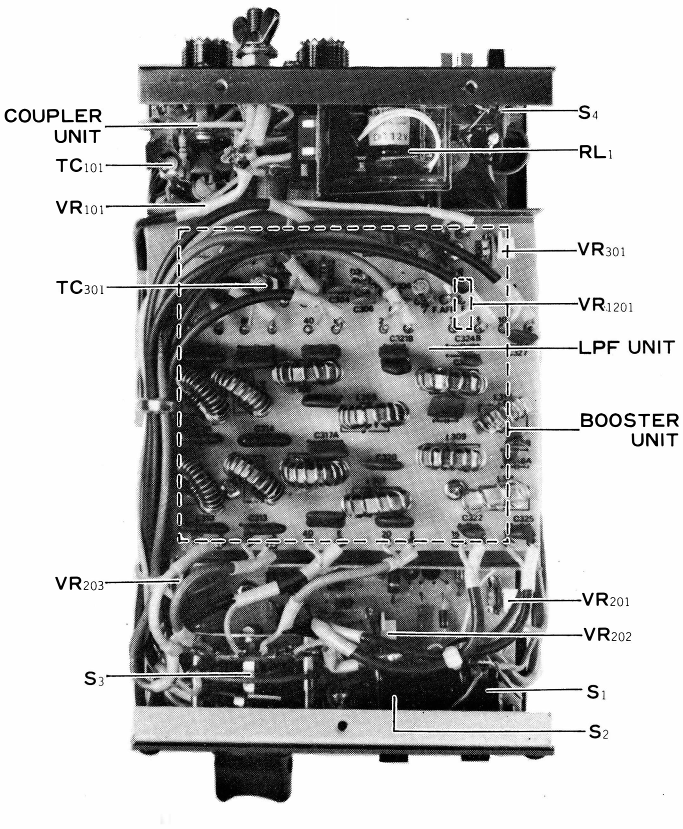
The following precautions should be observed to prevent damage to the FL-110.

(a) Do not exceed 14 Volts DC at the power receptacle. When operating mobile, check the battery voltage under load (full output on CW) with the engine running fast enough so that the car ammeter shows a "charge". Also, do not operate the FL-110 if the supply voltage is below 12 Volts DC.

(b) Avoid direct exposure to sunshine or water.

(c) Avoid extremely warm locations and maintain free air circulation around the heat sink.

The FL-110 does not require realignment with normal usage. Service, or replacement of a major component, may require subsequent realignment.



BOTTOM VIEW

REALIGNMENT PROCEDURE

(1) DELAY ADJUSTMENT (VR201)

The relay hold time can be adjusted by VR201. Clockwise rotation of VR201 will produce longer hold time.

(2) BALANCE ADJUSTMENT OF CM COUPLER (TC101, TC301)

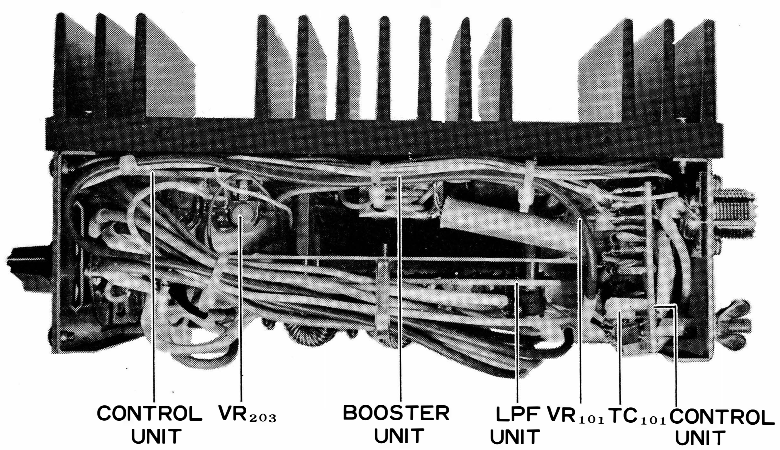
Set the power switch to "OFF". Connect dummy load/wattmeter, YP-150, to antenna connector. Set the output power of the exciter to 10 watts on the 3.5 MHz band. Connect a VTVM between a check point marked "R" in the control unit (+) and ground (-). Adjust TC101 for a minimum VTVM reading (less than 0.05V).

Connect plus (+) lead of VTVM to TP301 in the LPF unit. Set the power switch to "ON". Adjust TC301 for a minimum VTVM reading (less than 0.1 volts).

(3) AFP CIRCUIT ADJUSTMENT (VR202, VR203, VR301)

Prior to this adjustment, complete the adjustment of CM coupler described in Step (2).

Set VR202 to a fully clockwise position and VR203 to a fully counter-clockwise position in the control unit. Set VR301 in the LPF unit to a fully clockwise position. Connect the dummy load/wattmeter to the antenna connector and apply 3.5 MHz 20 watts carrier signal from the exciter. Slowly advance VR202 in a counter-clockwise direction and set VR202 to the point where the AFP relay is activated. Turn the power switch "OFF" and adjust the exciter output to 15 watts. Turn the power switch "ON". The AFP circuit should not work with a 15 watts drive power. If it should work with 15 watts, slowly advance VR203 in a clockwise direction.



RICHT SIDE VIEW

Repeat this procedure until the AFP circuit works without fail with a 20 watts input and does not work with a 15 watts input.

Then, rotate VR301 in a counter-clockwise direction until the AFP circuit is activated. Slowly rotate the VR301 back approximately 5 degrees in a clockwise direction. Set the exciter to receive. Connect VSWR meter, antenna coupler and dummy load/wattmeter to the antenna connector. Transmit on 3.5 MHz and adjust exciter output and antenna coupler to produce VSWR 1:3 at 70 watts output. Slowly rotate VR203 in a clockwise direction until the AFP circuit is activated.

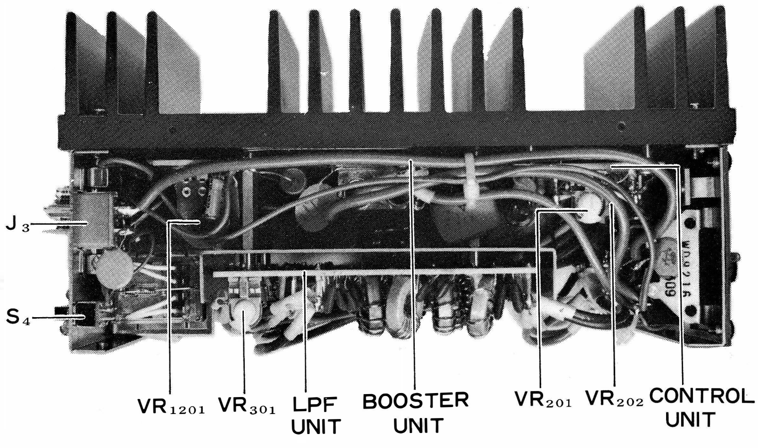
(4) CARRIER CONTROL CIRCUIT ADJUSTMENT (VR101)

After completion of above procedure, disconnect the PTT connection between the exciter and FL-110. Set VR101 to a fully clockwise position. Turn the power switch "ON" and apply 3.5 MHz 10 watts CW signal from the exciter. Carefully rotate VR101 in a counter-clockwise direction until the relay is activated. Recover the PTT connection.

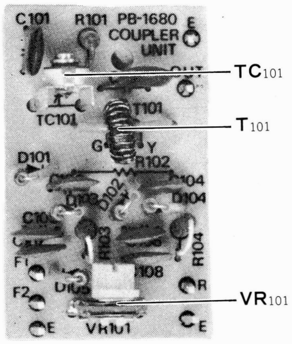
(5) PA BIAS ADJUSTMENT (VR1201)

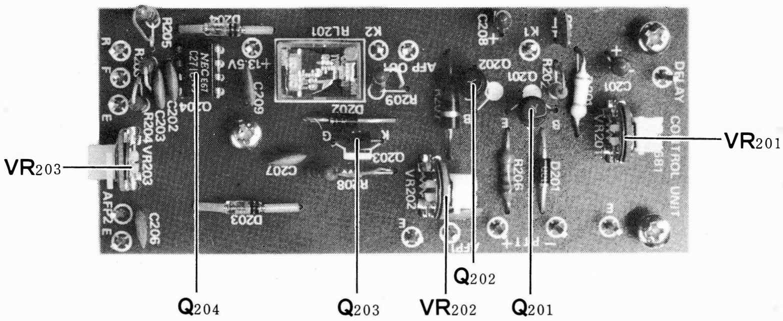
This adjustment is only required when the PA power transistors are replaced. Otherwise, please do not adjust the VR1201 as an incorrect setting will result in damage to the PA transistors.

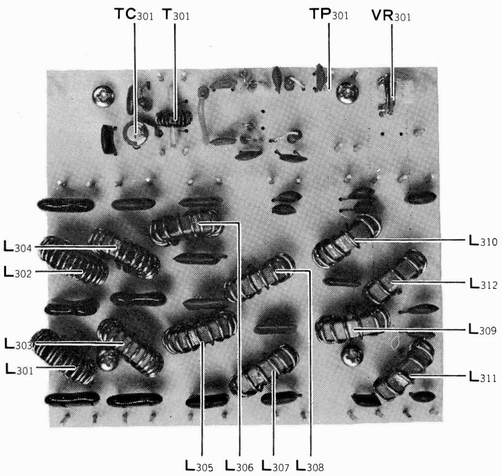
Connect 1A ammeter in the power supply line (cut red wire) to measure PA collector idle current. Disconnect the exciter from the FL-110. Set PTT switch to (-) position. Connect PTT terminal (pin 4) to ground. Turn the power switch "ON". Adjust VR1201 for 100mA idle current. Remove the ammeter from the circuit and recover the wiring cut for the ammeter installation.



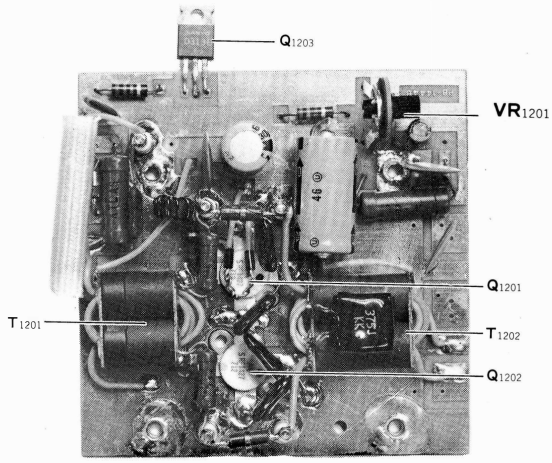
LEFT SIDE VIEW



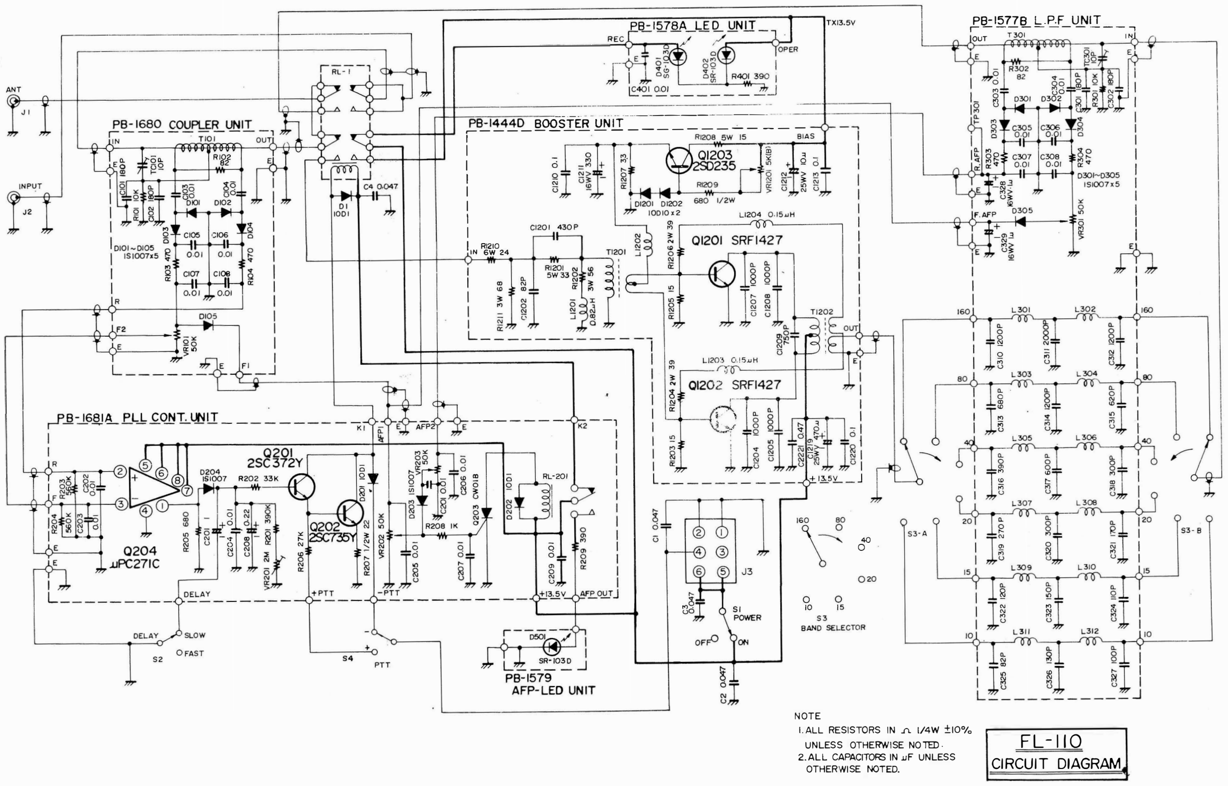




LPF UNIT (PB-1577)



BOOSTER UNIT (PB-1444B)



PARTS LIST

MAIN CHASSIS

D	DIODE		
1		Si	10D1(1N4002)
C	CAPACITOR		
	CERAMIC DISC		
1, 2, 3, 4		50WV	0.047μF
RL	RELAY		
1	AP3241		HC4-DC12V
RLS	RELAY SOCRET		
1	AP384455		HC4-SS
S	SWITCH		
1	POWER	WD-9216	
2	DELAY	WD-9216	
3	BAND	2-2-6(#003505 #003506)	
4	PTT	SS-F-22-08	
J	RECEPTACLE		
1	ANT	JSO-239	
2	INPUT	JSO-239	
3	POWER	QMS-AB6M	

BOOSTER UNIT

PB	PRINTED CIRCUIT BOARD		
1444D			
Q	TRANSISTOR		
1201, 1202		SRF1427	
1203		2SD313E(2SD235)	
D	DIODE		
1201, 1202		Si	10D10
R	RESISTOR		
	CARBON COMPOSITION		
1207		½W	3.3Ω
1203 1205		½W	15Ω
1209		½W	680Ω
	METALIC FILM		
1204, 1209		1W	39Ω
1208		3W	15Ω
1202		3W	56Ω
1211		3W	68Ω
1201		5W	33Ω
1210		6W	24Ω
VR	POTENTIOMETER		
1201	V18K3-2		5KΩB
C	CAPACITOR		
	DIPPED MICA		
		500WV	82PF
1201		500WV	430PF
1209		500WV	750PF
1204, 1205, 1207, 1208		500WV	1000PF
	CERAMIC DISC		
1210, 1213, 1220		50WV	0.1μF
	ELECTROLYTIC		
1211		16WV	330μF
1212		25WV	10μF
1219		25WV	470μF
T	TRANSFORMER		
1201	INPUT		#220025
1201	OUTPUT		#220026
L	INDUCTOR		
1201	RF CHOKE		#220034
1202	RF CHOKE		#220041
1203, 1204	RF CHOKE		#220035

COUPLER UNIT

PB	PRINTED CIRCUIT BOARD		
1680 (A～Z)			
D	DIODE		
101～105		Ge(GB)	1S1007(1N270)
R	RESISTOR		
	CARBON FILM		
102		¼W	82Ω
103, 104		¼W	470Ω
101		¼W	10KΩ
VR	POTENTIOMETER		
101	EVL-VOAA 00B54		50KΩB
C	CAPACITOR		
	DIPPED MICA		
101, 102		50WV	180PF
	CERAMIC DISC		
103～108		50WV	0.01μF
TC	TRIMMER CAPACITOR		
101	ECV-1ZW 10×40		10PF
T	TRANSFORMER		
101	CM COUPLER		#220027

CONTROL UNIT

PB	PRINTED CIRCUIT BOARD		
1681(A～Z)			
Q	IC, TRANSISTOR & THYRISTOR		
204		IC	μPC 271C
201		Tr	2SC 372Y
202			2SC 735Y
203		Thyristor	CW 01B
D	DIODE		
203, 204		Ge(GB)	1S1007(1N270)
201, 202		Si	10D1(1N4002)
R	RESISTOR		
	CARBON FILM		
209		¼W	390Ω
205		¼W	680Ω
208		¼W	1KΩ
206		¼W	27KΩ
202		¼W	33KΩ
201		¼W	390KΩ

203,204	¼W		560KΩ
	CARBON COMPOSITION		
207	½W		22Ω
VR	**POTENTIOMETER**		
202,203	EVL-VOAA	00B54	50KΩB
201	EVL-VOAA	00B26	2MΩB
C	**CAPACITOR**		
	CERAMIC DISC		
202~207,209,210	50WV		0.01μF
	TANTALUM		
208	16WV		0.22μF
201	16WV		1μF
RL	**RELAY**		
201	G2E		

LPF UNIT

PB	**PRINTED CIRCUIT BOARD**		
1577B			
D	**DIODE**		
301~305	Ge(GB)		1S1007(1N270)
R	**RESISTOR**		
	CARBON FILM		
302	¼W		82Ω
303,304	¼W		470Ω
301	¼W		10KΩ
VR	**POTENTIOMETER**		
301	EVL-VOAA	00B54	50KΩB
C	**CAPACITOR**		
	DIPPED MICA		
301,302	50WV		180PF
325	500WV		82PF
327	500WV		100PF
324	500WV		110PF(56PF×2)
322	500WV		120PF
326	500WV		130PF(68PF×2)
323	500WV		150PF
321	500WV		170PF(82PF×2)
319	500WV		270PF
318,320	500WV		300PF
316	500WV		390PF
317	500WV		600PF(300PF×2)
315	500WV		620PF
313	500WV		680PF
310,312,314	500WV		1200PF
311	500WV		2000PF
	CERAMIC DISC		
303~308	50WV		0.01μF
	ELECTROLYTIC		
328,329	16WV		1μF
TC	**TRIMMER CAPACITOR**		
301	ECV-1ZW	10×32	10PF
T	**TRANSFORMER**		
301	CM COUPLER		#220027

L	**INDUCTOR**		
301,320	160m	LOWPASS	#220148A
303,304	80m	LOWPASS	#220147A
305,306	40m	LOWPASS	#220214
307	20m	LOWPASS(A)	#220254
308	20m	LOWPASS(B)	#220215A
309	15m	LOWPASS(A)	#220216
310	15m	LOWPASS(B)	#220217
311,312	10m	LOWPASS	#220218

LED BOARD

PB	**PRINTED CIRCUIT BOARD**	
1578A	REC,OPER INDICATOR	
1579	AFP INDICATOR	
D	**LED**	
401	SG-103D	
402,501	SR-103D	
R	**RESISTOR**	
	CARBON FILM	
401	¼W	390Ω
C	**CAPACITOR**	
	CERAMIC DISC	
401	50WV	0.047μF

ACCESSORIES

COAXIAL PLUG	JPL-259	2
DC POWER CORD	#240026	1
POWER PLUG	QMS-6FK	(1)
FUSE HOLDER	SN·1102	(1)
FUSE	30A	(1)
FUSE	30A	1

YAESU

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